

CLAIMS

What is claimed is:

1. An illumination optical system comprising:
a light source which emits light; and
a light separation/integration device including a diffraction device which is provided on at least one incident side of the light separation/integration device, wherein the diffraction device diffracts the light to adjust an incident angle thereof to a predetermined range.
2. The illumination optical system of claim 1, wherein the light separation/integration device is an X-cube.
3. The illumination optical system of claim 1, wherein the diffraction device is a diffraction optical element (DOE) or a holographic optical element (HOE).
4. The illumination optical system of claim 2, wherein the diffraction device is a diffraction optical element (DOE) or a holographic optical element (HOE).
5. The illumination optical system of claim 1, further comprising a light guide unit which is provided on an optical path between the light source and the light separation/integration device.
6. The illumination optical system of claim 2, further comprising a light guide unit which is provided on an optical path between the light source and the light separation/integration device.
7. The illumination optical system of claim 5, wherein the light guide unit is an optical fiber.
8. The illumination optical system of claim 6, wherein the light guide unit is an optical fiber.

9. The illumination optical system of claim 1, further comprising a relay lens unit which is provided between the light source and the light separation/integration device.

10. The illumination optical system of claim 2, further comprising a relay lens unit which is provided on an optical path between the light source and the light separation/integration device.

11. The illumination optical system of claim 1, further comprising an optical path separation device which is provided between the light source and the light separation/integration device.

12. The illumination optical system of claim 2, further comprising an optical path separation device which is provided between the light source and the light separation/integration device.

13. The illumination optical system of claim 11, wherein the optical path separation device is a total internal reflection (TIR) prism.

14. The illumination optical system of claim 12, wherein the optical path separation device is a total internal reflection (TIR) prism.

15. An image display apparatus to form an image, comprising:
an illumination optical system comprising a light source which emits light and a light separation/integration device which includes a diffraction device provided on at least one incident side thereof, wherein the diffraction device diffracts the light to adjust an incident angle thereof to a predetermined range;
an image optical system which modulates the light incident from the illumination optical system to form the image; and
a projection optical system which projects the light reflected from the image optical system.

16. The image display apparatus of claim 15, wherein the light separation/integration device is an X-cube.

17. The image display apparatus of claim 15, wherein the diffraction device is a diffraction optical element (DOE) or a holographic optical element (HOE).

18. The image display apparatus of claim 15, further comprising a light guide unit which is provided on an optical path between the light source and the light separation/integration device.

19. The image display apparatus of claim 18, wherein the light guide unit is an optical fiber.

20. The image display apparatus of claim 15, wherein the image optical system comprises a panel which modulates the light incident from the illumination optical system according to an image signal of the display apparatus to generate the image.

21. The image display apparatus of claim 20, wherein the illumination optical system further comprises a glass road which uniformizes an intensity of the light between the light separation/integration device and the panel.

22. The image display apparatus of claim 21, wherein the image optical system further comprises an optical path separation device which is provided on an optical path between the glass road and the panel, reflects the light from the light separation/integration device and transmits the light from the panel.

23. The image display apparatus of claim 22, wherein the image optical system further comprises a collecting lens which is provided on an optical path between the glass road and the optical path separation device.

24. The image display apparatus of claim 15, wherein the projection optical system comprises a projection lens which projects the image formed by the image optical system onto a screen external to the display apparatus.

25. The image display apparatus of claim 15, wherein the illumination optical system further comprises a relay lens unit which is provided on an optical path between the light source and the light separation/integration device.

26. The image display apparatus of claim 15, wherein the image optical system comprises a relay lens unit which is provided on an optical path between the light separation/integration device and the projection optical system.

27. The image display apparatus of claim 20, wherein the image optical system further comprises a relay lens unit which is provided on an optical path between the light separation/integration device and the projection optical system.

28. The image display apparatus of claim 15, wherein the image optical system comprises an optical path separation device which is provided on an optical path between the light source and the light separation/integration device, reflects the light from the light source and transmits the light from the light separation/integration device.

29. The image display apparatus of claim 20, wherein the image optical system further comprises an optical path separation device which is provided on an optical path between the light source and the light separation/integration device, reflects the light from the light separation/integration device and transmits the light from the panel.

30. The image display apparatus of claim 22, wherein the optical path separation device is a total internal reflection (TIR) prism.

31. The image display apparatus of claim 29, wherein the optical path separation device is a total internal reflection (TIR) prism.

32. The illumination optical system of claim 1, wherein the diffraction device diffracts the light so as to have the light incident on a coating layer of the light separation/integration device at a diverging angle of a minimum of 0 degrees and a maximum of 4-8 degrees.

33. The illumination optical system of claim 1, wherein the diffraction device decreases the incident angle of the light so as to reduce a light loss of the illumination optical system.

34. The illumination optical system of claim 1, wherein the diffraction device is directly formed on the incident side of the light separation/integration device, or manufactured separately and attached to the light separation/integration device.

35. The illumination optical system of claim 1, wherein the diffraction device is a diffraction device having a power.

36. The illumination optical system of claim 2, wherein:
the X-cube includes a coating layer which transmits or reflects light according to the incident angle of the light, and
the diffraction device adjusts the incident angle of the light on the coating layer so as to reduce a light loss of the illumination optical system.

37. The image display apparatus of claim 15, wherein the diffraction device is a diffraction device having a power and decreases the incident angle of the light so as to reduce a light loss of the image display apparatus.

38. The image display apparatus of claim 15, wherein:
the light separation/integration device includes a coating layer which separates the light incident thereon, and
the image optical system includes panels which receive the separated lights, respectively, and modulates the received lights to generate the image.

39. The image display apparatus of claim 15, wherein the diffraction device decreases the incident angle of the light so as to reduce a light loss of the illumination optical system.

40. The image display apparatus of claim 22, wherein the panel is a digital micromirror device and the optical path separation device is a total internal reflection (TIR) prism.

41. The image display apparatus of claim 22, wherein the panel is a liquid crystal on silicon (LCOS) and the optical path separation device is a polarization beam splitter (PBS).

42. An illumination optical system comprising:
light sources which emit lights having different wavelengths; and
a light separation/integration device including diffraction devices which are provided on incident sides of the light separation/integration device corresponding to the lights, wherein each of the diffraction devices diffracts the corresponding light to adjust an incident angle thereof to a predetermined range.

43. The illumination optical system of claim 42, wherein each of the diffraction devices adjusts a diverging angle of the corresponding light incident on the light separation/integration device so as to reduce a light loss and increase a light efficiency of the corresponding light output from the illumination optical system.

44. The illumination optical system of claim 11, wherein the optical path separation device reflects the light from the light source and transmits the light from the light separation/integration device.